UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Alaska Fisheries Science Center
Resource Assessment and Conservation Engineering Division
7600 Sand Point Way Northeast
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Seattle, Washington 98115-0070

March 18, 1997 F/AKC1:RRL

CRUISE RESULTS
NOAA Ship *Miller Freeman*, Cruise 96-15
1996 West Coast Upper Continental Slope Groundfish Trawl Survey
October 15-November 26, 1996

The Resource Assessment and Conservation Engineering (RACE) Division of the Alaska Fisheries Science Center (AFSC) completed a six-week bottom trawl survey of the upper continental slope groundfish resources off Washington and Oregon on 26 November 1996. The survey covered the upper continental slope habitat 183-1,280 m deep in the International North Pacific Fisheries Commission (INPFC) U.S. Vancouver and Columbia areas (U.S./Canada border-lat. 43°00'N). Sampling for the survey began near Nitinat Canyon (lat. 48°05'N) and progressed southward to Cape Blanco (Fig. 1). This report summarizes the preliminary results of the survey.

ITINERARY

The 1996 slope survey was conducted during two legs aboard the NOAA Ship *Miller Freeman* between October 15 and November 26. Scientific personnel were exchanged during a mid-cruise break in Astoria, Oregon on 5-7 November.

OBJECTIVES

Results from annual groundfish slope surveys are used by fishery managers to assess stock conditions and establish annual harvest guidelines for sablefish (*Anoplopoma fimbria*), Dover sole (*Microstomus pacificus*), and two species of thornyhead rockfish (*Sebastolobus alascanus* and *S. altivelis*). Due to limited vessel time each year, slope groundfish trawl surveys traditionally cover different but contiguous parts of the west coast upper continental slope. The groundfish resources of the U.S.

Vancouver area upper continental slope were last surveyed in 1992. The Columbia area has never been surveyed in its entirety within a single year but various sections of the Columbia area were surveyed in 1984, 1988, 1989, 1992, and 1993.

The specific objectives for this cruise were:

1. to describe and monitor the abundance, biological characteristics, and the geographic and bathymetric distribution of major groundfish resources inhabiting the upper continental slope of the INPFC U.S. Vancouver and Columbia management areas;

2. to obtain age samples and biological data including sex, length-weight relationships, and maturity for shortspine and longspine thornyhead, sablefish, Dover sole, and arrowtooth flounder (*Atheresthes stomias*) for stock assessment purposes; and

3. to describe the slope fish community and how it varies with bathymetry.

VESSEL AND GEAR

The NOAA Ship *Miller Freeman* is a 65.5 m stern trawler equipped with a modern trawl sampling system and navigation and fishing electronics. A polyethylene high-opening Nor'eastern bottom trawl, built to RACE Division standards and equipped with mud-sweep roller gear, was used to collect all samples. Dimensions of this net are 27.2 m headrope and 37.4 m footrope including the "flying wings." The body is constructed of 127 mm stretched-mesh polyethylene netting, 89 mm stretched-mesh web in the codend, and a 32 mm stretched-mesh codend liner. The roller gear is constructed of 203 mm solid rubber disks strung on 16 mm high tensile chain. Connecting the footrope and roller gear at each attachment point is a toggle, two shackles, and a single link of 10 mm alloy chain. Three 55 m dandylines made of 16 mm galvanized steel cable lead from each wing to a 1.8 x 2.7 m steel V-door weighing 1,000 kg. Each door has a 4-point bridle on its backside made with 13 mm long link chain having 33 links forward, top and bottom, and 22 links aft, top and bottom. Instruments attached to the trawl gear to monitor gear performance included the SCANMAR[1] equipment for measuring net dimensions, a Furuno[1]

[1]Reference to trade names or commercial firms does not constitute U.S. government endorsement.

wireless netsonde for real-time monitoring of the headrope height, and a bottom contact sensor on the footrope. A Wesmar[1] sonar was used to establish good trawl performance during the initial part of the cruise and for proper net configuration during wire marking. A Richard Brancker[1] XL-200 submersible data logger was attached to the trawl and used in conjunction with a Trimble[1] Global Positioning System (GPS) unit to record data on the time, depth, water temperature and geodetic position during each trawl. These data were integrated with fishing dimensions of the net, producing a comprehensive set of data describing gear performance in space and time.

SURVEY DESIGN AND METHODS

The sampling design used for this survey was a cross between a systematic and random design. Sampling was conducted between 183 and 1,280 m in six strata of 183 m depth intervals (183-366, 367-549, 550-732, 733-914, 915-1,097, 1,098-1,280 m). There were 225 stations along 34 east-west tracklines spaced 16.7 km apart between lat. 48°05'N near Nitinat Canyon and lat. 43°00'N near Cape Blanco. Stations were surveyed with the ship's fathometer and GPS plotter before setting the net. Sampling at each station consisted of a controlled bottom trawl haul with net metering instrumentation attached to the trawl to monitor gear performance. After the trawl settled to the bottom, it was towed for 30 minutes using scope ratios ranging from 1.5 to 2.5. Towing speed was approximately 3.7 km/hour (2.3 knots) at all stations and trawling operations continued around the clock (24 hours per day). The trawl's fishing dimensions were monitored with the Furuno netsonde at all depths, and with SCANMAR at stations shallower than 900 m. Station data, including time, geodetic position, trawl dimensions, distance fished, temperature profile, and catch and length information, were stored for later analysis using shipboard computer systems.

All catches were sorted to the lowest possible taxon, weighed, counted, and processed according to standard RACE protocols. Samples of most fish species caught in every haul were measured for length composition. Stratified otolith (age) samples were collected from the primary target groundfish species by sex-centimeter intervals in three depth strata (183-548 m, 549-913 m, and 914-1,279 m). Other biological data were collected from the major fish species encountered. Special study collections were stored in appropriate fixatives or frozen.

RESULTS

Two hundred and fifty (250) tows were attempted during the survey. Out of 225 possible stations, 203 stations were sampled successfully (Figure 1). Twenty-two stations were abandoned because they were too rough or steep. One additional deep tow was done at 1450 m to collect biological specimens. The remainder of the attempted tows were unsuccessful due to hang-ups, rips, bad bottom, excessive mud in tows, crossing into the wrong stratum, large catches of dogfish, or gear problems. SCANMAR net mensuration data were obtained from 170 tows, submersible bathythermograph data from 243 tows, bottom contact sensor data from 227 tows, and GPS course and position data from 249 tows.

A total of 149 fish species were identified in catches throughout the survey. Samples also contained representatives from numerous orders of invertebrates. Table 1 summarizes the biological data collected from fish species. Specimen ages will be determined by the NMFS Alaska Fisheries Science Center and NMFS Northwest Fisheries Science Center using the collected otoliths.

Tables 2 and 3 list the dominant groundfish species and selected crab species caught in the U.S. Vancouver and Columbia INPFC areas. Catch rates are expressed in kg/ha and ranked in order of catch per unit of effort (CPUE) by depth stratum. Spiny dogfish, Dover sole, and Pacific hake had the highest mean catch rates in strata 1 and 2, and longspine thornyhead, Dover sole, true Tanner crab, sablefish, Pacific grenadier and giant grenadier had the highest mean catch rates in the deepest 4 strata. Plots of unweighted size frequency of primary groundfish species are provided in Figures 2 through 9, showing their frequency by depth stratum and by sex for the U.S. Vancouver and Columbia INPFC areas. Further analyses will be completed to describe distribution and to estimate biomass, population size, and age composition of these groundfish resources. Length-weight and length-maturity relationships will be derived to assist managers in assessing the status of important upper slope groundfish species.

Three fishers from Astoria, Oregon, also participated during the second leg of the cruise. They observed survey work in progress and were pleased with the performance of the slope survey trawl and survey methods.

SCIENTIFIC PERSONNEL

Leg I (15 October-5 November 1996)

Day Watch (noon to midnight)

Bill Flerx (Watch Leader), AFSC	Fishery Biologist
Mark Zimmermann (Deck Boss), AFSC	Fishery Biologist
Allen Harvison, AFSC	Gear Specialist
Jim Smart, AFSC	Gear Specialist
Bruce Pederson, ODFW	Fishery Biologist
Dan Kamikawa, NWFSC	Fishery Biologist

Night Watch (midnight to noon)

Robert Lauth (Watch Leader), AFSC	Chief Scientist
Robin Harrison (Deck Boss), AFSC	Fishery Biologist
Mike Macewan, AFSC	Gear Specialist
Marion Mann, ODFW	Fishery Biologist
Roger Clark, AFSC	Fishery Biologist

Leg II (7-26 November 1996)

Day Watch (noon to midnight)

Mark Wilkins (Watch Leader), AFSC	Chief Scientist
Bill Flerx (Deck Boss), AFSC	Fishery Biologist
Yvonne Dereynier, NWR	Fishery Biologist
Dave King, AFSC	Gear Specialist
Dan Kamikawa, NWFSC	**Fishery Biologist**
Joe O'Malley, ODFW	**Fishery Biologist**

Night Watch (midnight to noon)

Robert Lauth (Watch Leader), AFSC	Fishery Biologist
Michael Martin (Deck Boss), AFSC	Fishery Biologist
James Orr, AFSC	Fishery Biologist
Jim Stark, AFSC	Fishery Biologist
Coalter Lathrop, ST	Fishery Biologist
Jeff Drazen, SIO	Fishery Biologist

AFSC = Alaska Fisheries Science Center, Seattle, WA
NWFSC = Northwest Fisheries Science Center, Newport, OR
NWR = Northwest Regional Office, Seattle, WA
ODFW = Oregon Department of Fish and Wildlife, Newport, OR
SIO = Scripps Institution of Oceanography, San Diego, CA
ST = Science and Technology, Silver Springs, MD

For further information, contact Dr. Gary Stauffer, Director, Resource Assessment and Conservation Engineering Division, Alaska Fisheries Science Center, National Marine Fisheries Service, 7600 Sand Point Way NE., BIN C15700, Building 4, Seattle, WA 98115-0070. Telephone (206) 526-4170.

Table 1.--Biological data collected during the 1996 west coast upper continental slope groundfish survey of the U.S. Vancouver and Columbia INPFC areas.

Common name of fish species	Length-frequency data	Age structures	Maturities	Weights	Ovaries	Tissue samples
Brown cat shark	1,933			208		
Spiny dogfish	5,613					
Deepsea skate	4					
Bering skate	952			16		
Longnose skate	459					
Black skate	482			60		
Spotted ratfish	1,085					
Arrowtooth flounder	817	340	538	549		
Pacific halibut	78					
Slender sole	6,208					
Petrale sole	237					
English sole	295					15
Dover sole	14,259	1,202	1,797	1,831		15
Deepsea sole	1,740					15
Rex sole	7,567					15
Blacktip poacher	11					
Smootheye poacher	4					
Bigeye poacher	31					
Blackfin poacher	84					
California slickhead	2,090			161		15
Threadfin slickhead	738			104		
Fangtooth	3					
Sablefish	4,746	1,495	2,338	2,288	326	15
Jack mackerel	148					
California grenadier	3					
Pacific grenadier	10,249			44		30
Giant grenadier	4,496					16
Popeye grenadier	56					27
Filamented grenadier	2					
Threadfin sculpin	32					
Blob sculpin	4					
Pacific cod	6					
Pacific flatnose	5,760			192		15
Lingcod	88					
Blacktail snailfish	578					
Pacific hake	17,769					100
Chinook salmon	16					
Twoline eelpout	1,080			184		
Snakehead eelpout	746			60		
Bigfin eelpout	2,606			222		
Black eelpout	3,466			98		
Blackbelly eelpout	50					
Shortspine thornyhead	17,323	1,544	2,328	2,408		15
Longspine thornyhead	38,135	998	1,451	1,523		15
Rougheye rockfish	124					

Table 1.--Continued.

Common name of fish species	Length-frequency data	Age structures	Maturities	Weights	Ovaries	Tissue samples
Pacific ocean perch	1,550					
Aurora rockfish	303			61		
Silvergray rockfish	2		.			
Darkblotched rockfish	544					
Splitnose rockfish	2,319					15
Greenstriped rockfish	965					
Widow rockfish	54					
Yellowtail rockfish	15					
Rosethorn rockfish	283					
Shortbelly rockfish	129					
Blackgill rockfish	1					
Bocaccio	6					
Canary rockfish	7					
Redstripe rockfish	20					
Redbanded rockfish	91					
Stripetail rockfish	498					
Sharpchin rockfish	885					
Bank rockfish	1					
Shortraker rockfish	8					
Yellowmouth rockfish	2					

Table 2.--Mean CPUE (kg/ha) of the 20 most abundant groundfish and selected crab species caught in the U.S. Vancouver INPFC area during the 1996 west coast upper continental slope groundfish survey.

Species	Stratum 1 183-366 m	Species	Stratum 2 367-549 m	Species	Stratum 3 550-732 m
Spiny dogfish	100.31	Dover sole	36.09	Dover sole	10.04
Pacific hake	88.73	Pacific hake	27.28	Longspine thornyhead	9.81
Pacific ocean perch	24.56	Shortspine thornyhead	7.88	True tanner crab	8.26
Dover sole	19.56	Sablefish	4.63	Shortspine thornyhead	4.02
Slender sole	13.19	Brown cat shark	2.38	Deepsea sole	1.76
Sablefish	10.38	Longspine thornyhead	2.37	Twoline eelpout	1.63
Greenstriped rockfish	9.23	Bigfin eelpout	1.71	Pacific hake	1.54
Spotted ratfish	7.92	Rex sole	1.65	Pacific grenadier	1.14
Arrowtooth flounder	6.18	Black eelpout	1.65	Giant grenadier	1.13
Rex sole	5.24	Twoline eelpout	1.07	Pacific flatnose	1.09
Longnose skate	4.88	Longnose skate	0.98	Black eelpout	0.98
Shortspine thornyhead	4.10	Spiny dogfish	0.82	King-of-the-salmon	0.49
Pacific halibut	4.05	Rougheye rockfish	0.80	Brown cat shark	0.41
Bering skate	2.95	Bering skate	0.77	Black skate	0.35
Splitnose rockfish	1.88	Slender sole	0.68	Blacktail snailfish	0.35
Rosethorn rockfish	1.84	Shortraker rockfish	0.55	Snakehead eelpout	0.28
English sole	1.41	True tanner crab	0.43	Black hagfish	0.08
Lopholithodes foraminatus	1.27	Pacific ocean perch	0.39	Pacific viperfish	0.05
Petrale sole	1.16	Arrowtooth flounder	0.36	Spiny dogfish	0.04
Bigfin eelpout	1.08	Blacktail snailfish	0.34	Longfin dragonfish	0.04
Number of hauls	6	Number of hauls	4	Number of hauls	4

Species	Stratum 4 733-914 m	Species	Stratum 5 915-1,097 m	Species	Stratum 6 1,098-1,280 m
Longspine thornyhead	22.23	Longspine thornyhead	30.22	Longspine thornyhead	18.65
True tanner crab	9.90	Sablefish	6.26	Giant grenadier	17.48
Shortspine thornyhead	2.52	Giant grenadier	5.69	Sablefish	10.07
Giant grenadier	2.09	Pacific grenadier	5.24	Pacific grenadier	7.56
Deepsea sole	1.80	True tanner crab	5.07	True tanner crab	2.34
Sablefish	1.51	Shortspine thornyhead	3.24	Shortspine thornyhead	2.20
Dover sole	0.98	Deepsea sole	1.98	Black skate	1.98
Twoline eelpout	0.70	Twoline eelpout	1.33	Pacific flatnose	0.84
Pacific grenadier	0.64	California slickhead	1.03	Twoline eelpout	0.71
Black hagfish	0.52	Black skate	0.90	Blob sculpin	0.31
Snakehead eelpout	0.26	Pacific flatnose	0.32	Deepsea sole	0.29
Black skate	0.19	*Lithodes couesi*	0.27	Blacksmelt unident.	0.09
Brown cat shark	0.13	Dover sole	0.24	Pacific hake	0.08
California slickhead	0.12	Snakehead eelpout	0.17	California slickhead	0.08
Blacksmelt unident.	0.08	Pacific hake	0.13	*Lithodes couesi*	0.06
Pacific hake	0.08	Black hagfish	0.11	Lanternfish unident.	0.06
Pacific flatnose	0.08	Spiny dogfish	0.08	Pacific viperfish	0.05
Spotted ratfish	0.06	Blacksmelt unident.	0.07	Black hagfish	0.05
Blacktail snailfish	0.05	Brown cat shark	0.07	Snakehead eelpout	0.05
Threadfin slickhead	0.03	*Careproctus* sp.	0.05	Crested bigscale	0.02
Number of hauls	4	Number of hauls	5	Number of hauls	3

Table 3.--Mean CPUE (kg/ha) of the 20 most abundant groundfish and selected crab species caught in the Columbia INPFC area during the 1996 west coast upper continental slope groundfish survey.

Species	Stratum 1 183-366 m	Species	Stratum 2 367-549 m	Species	Stratum 3 550-732 m
Spiny dogfish	239.89	Pacific hake	85.94	Longspine thornyhead	14.24
Pacific hake	213.88	Dover sole	25.46	True tanner crab	12.90
Dover sole	36.58	Shortspine thornyhead	9.41	Sablefish	12.52
Rex sole	10.70	Rex sole	6.88	Dover sole	8.41
Sablefish	9.86	Sablefish	6.06	Shortspine thornyhead	5.35
Jack mackerel	6.78	Arrowtooth flounder	4.48	Giant grenadier	5.06
Shortspine thornyhead	6.62	Spiny dogfish	4.36	Pacific hake	3.52
Longnose skate	5.62	Longnose skate	2.97	Brown cat shark	0.88
Slender sole	5.24	Pacific halibut	2.08	Pacific flatnose	0.82
Splitnose rockfish	4.31	Bigfin eelpout	1.59	Black eelpout	0.80
Darkblotched rockfish	3.62	Brown cat shark	1.57	Deepsea sole	0.78
Pacific ocean perch	3.57	Bering skate	1.47	Black skate	0.78
Bering skate	2.74	Longspine thornyhead	1.35	Twoline eelpout	0.73
Spotted ratfish	2.72	Black eelpout	1.20	Pacific grenadier	0.58
Arrowtooth flounder	2.02	Pacific ocean perch	0.82	California slickhead	0.34
Bigfin eelpout	1.89	Slender sole	0.80	Rex sole	0.29
Sharpchin rockfish	1.68	*Lopholithodes foraminatus*	0.68	Arrowtooth flounder	0.26
Petrale sole	1.57	Aurora rockfish	0.62	Longnose skate	0.26
Lingcod	1.52	Rougheye rockfish	0.54	Black hagfish	0.25
Shortbelly rockfish	1.33	True tanner crab	0.48	Blacktail snailfish	0.16
Number of hauls	38	Number of hauls	32	Number of hauls	28

Species	Stratum 4 733-914 m	Species	Stratum 5 915-1,097 m	Species	Stratum 6 1,098-1,280 m
Longspine thornyhead	23.54	Longspine thornyhead	31.93	Longspine thornyhead	26.03
True tanner crab	14.60	True tanner crab	12.15	Giant grenadier	22.17
Sablefish	5.71	Pacific grenadier	8.15	Sablefish	15.87
Dover sole	4.14	Sablefish	7.26	Pacific grenadier	15.08
Giant grenadier	3.78	Giant grenadier	6.89	True tanner crab	9.00
Shortspine thornyhead	1.80	Shortspine thornyhead	3.81	Black skate	3.55
Deepsea sole	1.18	Dover sole	2.80	Shortspine thornyhead	3.29
California slickhead	1.10	Black skate	1.38	Pacific flatnose	3.20
Pacific grenadier	0.69	California slickhead	1.31	Dover sole	2.63
Threadfin slickhead	0.46	Deepsea sole	1.27	Deepsea sole	1.47
Brown cat shark	0.41	Twoline eelpout	0.56	Twoline eelpout	1.04
Black hagfish	0.38	Pacific flatnose	0.48	*Paralomis multispina*	0.53
Pacific hake	0.36	Black hagfish	0.38	Deepsea skate	0.43
Twoline eelpout	0.31	Threadfin slickhead	0.27	California slickhead	0.35
Black skate	0.25	Pacific hake	0.23	Blob sculpin	0.20
Ragfish	0.24	Snakehead eelpout	0.23	Pacific hake	0.19
Pacific sleeper shark	0.19	Brown cat shark	0.19	Blacksmelt unident.	0.17
Blacksmelt unident.	0.16	Blacksmelt unident.	0.17	Pacific sleeper shark	0.11
Pacific flatnose	0.16	*Lithodes couesi*	0.08	Black hagfish	0.11
Snakehead eelpout	0.14	Blob sculpin	0.05	Snakehead eelpout	0.09
Number of hauls	29	Number of hauls	27	Number of hauls	27

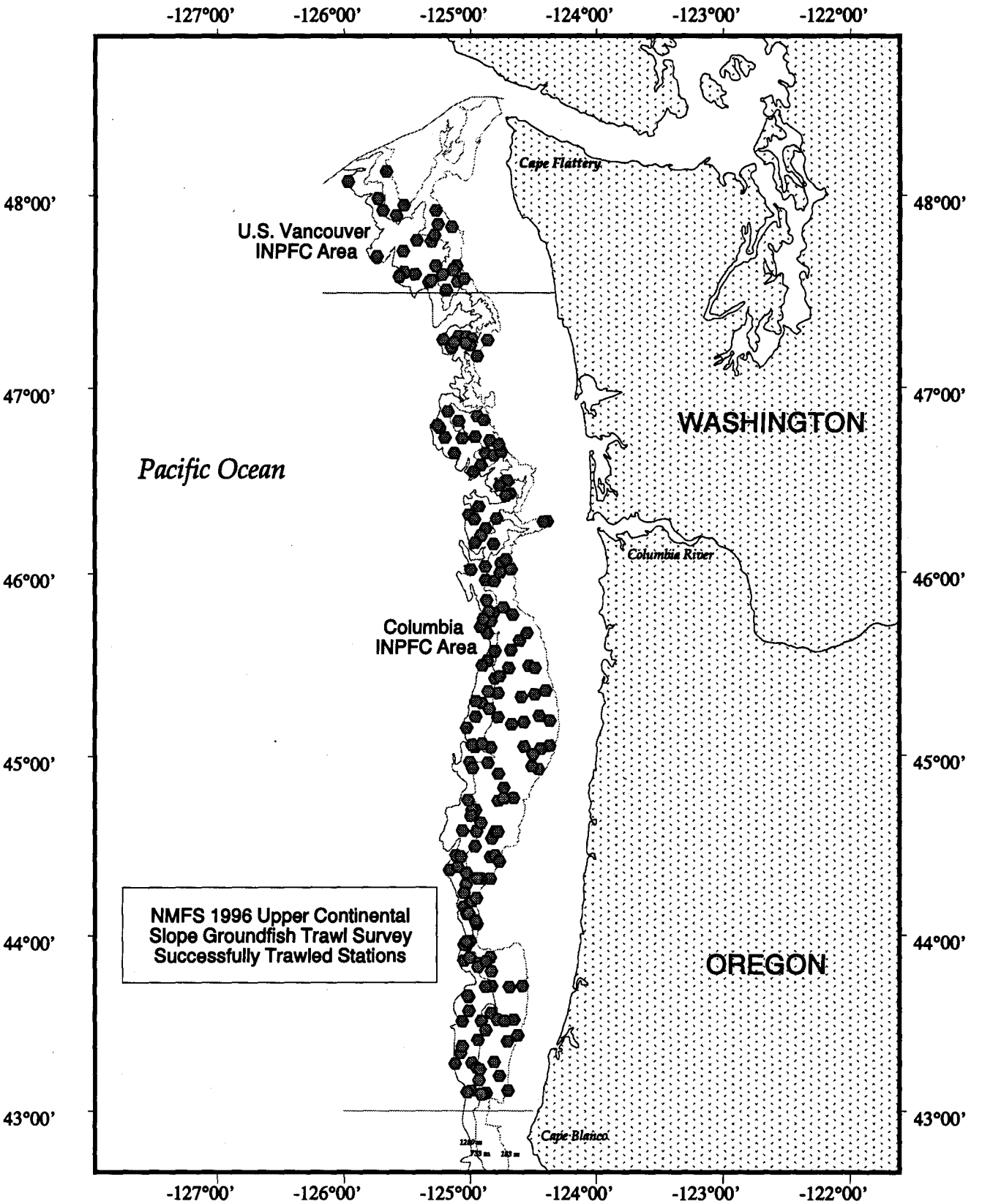

Figure 1.--Map showing the location of 203 successful bottom trawl tows sampled during the NMFS 1996 west coast continental slope groundfish survey.

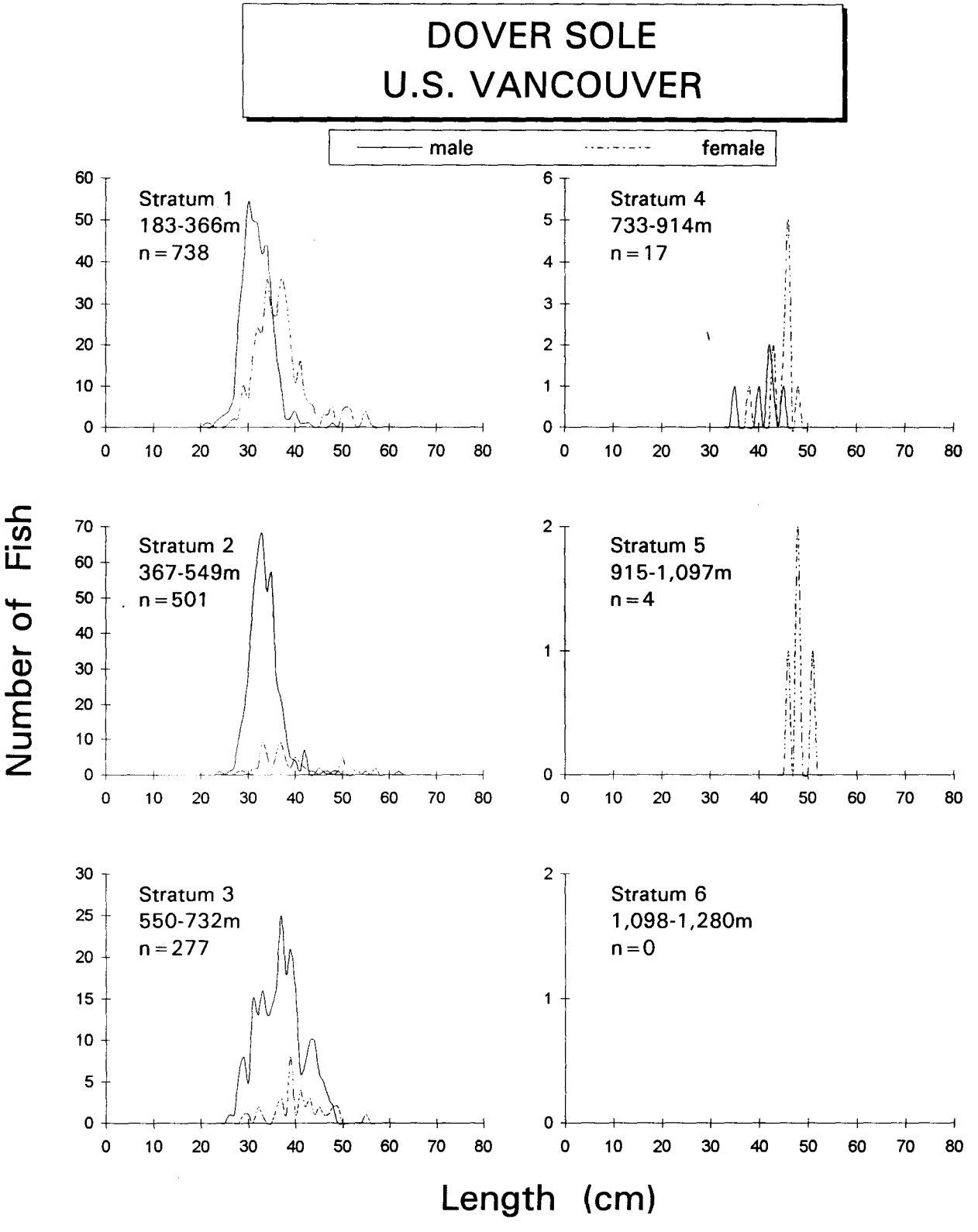

Figure 2.--Unweighted length frequency of Dover sole by sex and by stratum for the U.S. Vancouver INPFC area.

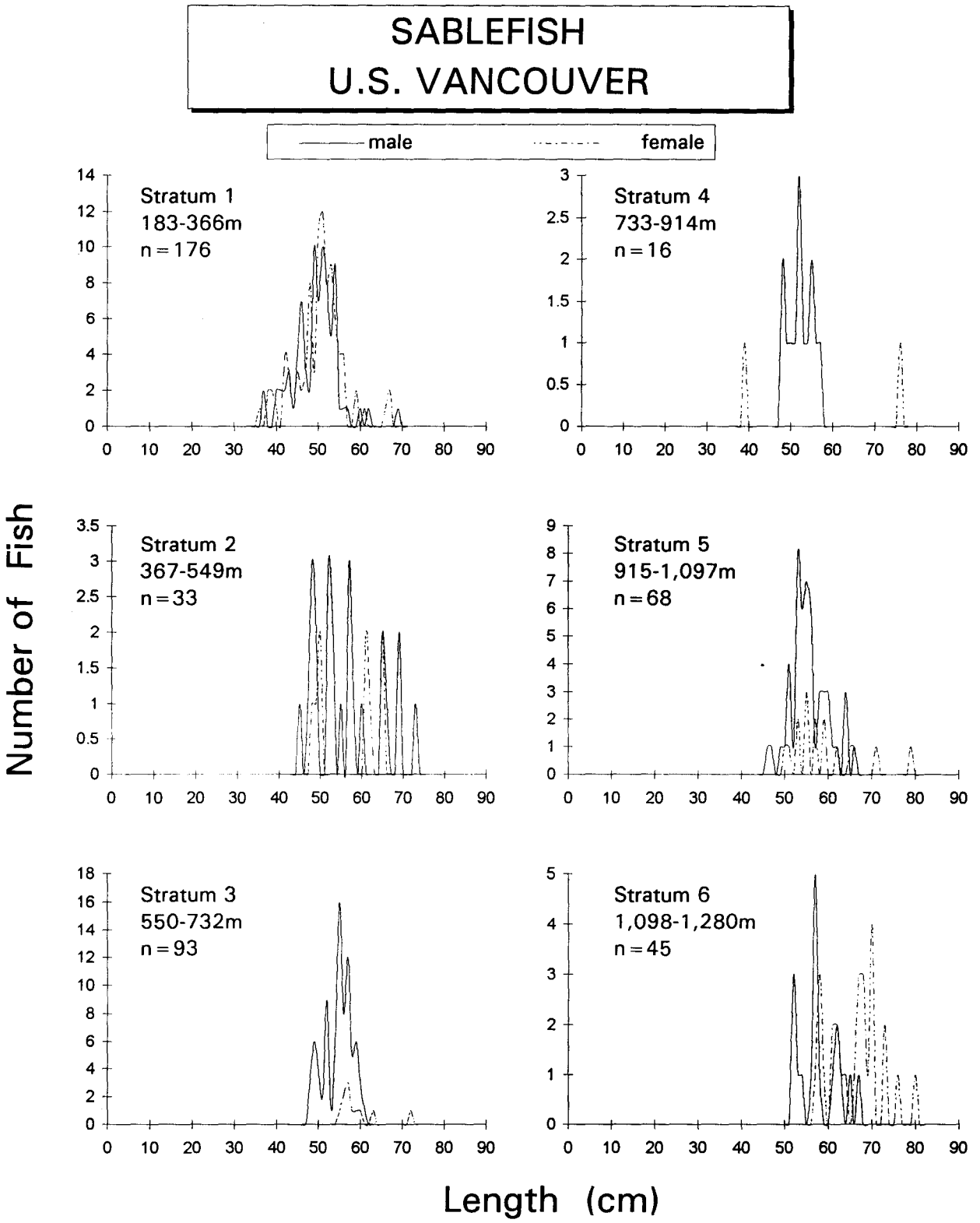

Figure 3.--Unweighted length frequency of sablefish by sex and by stratum for the U.S. Vancouver INPFC area.

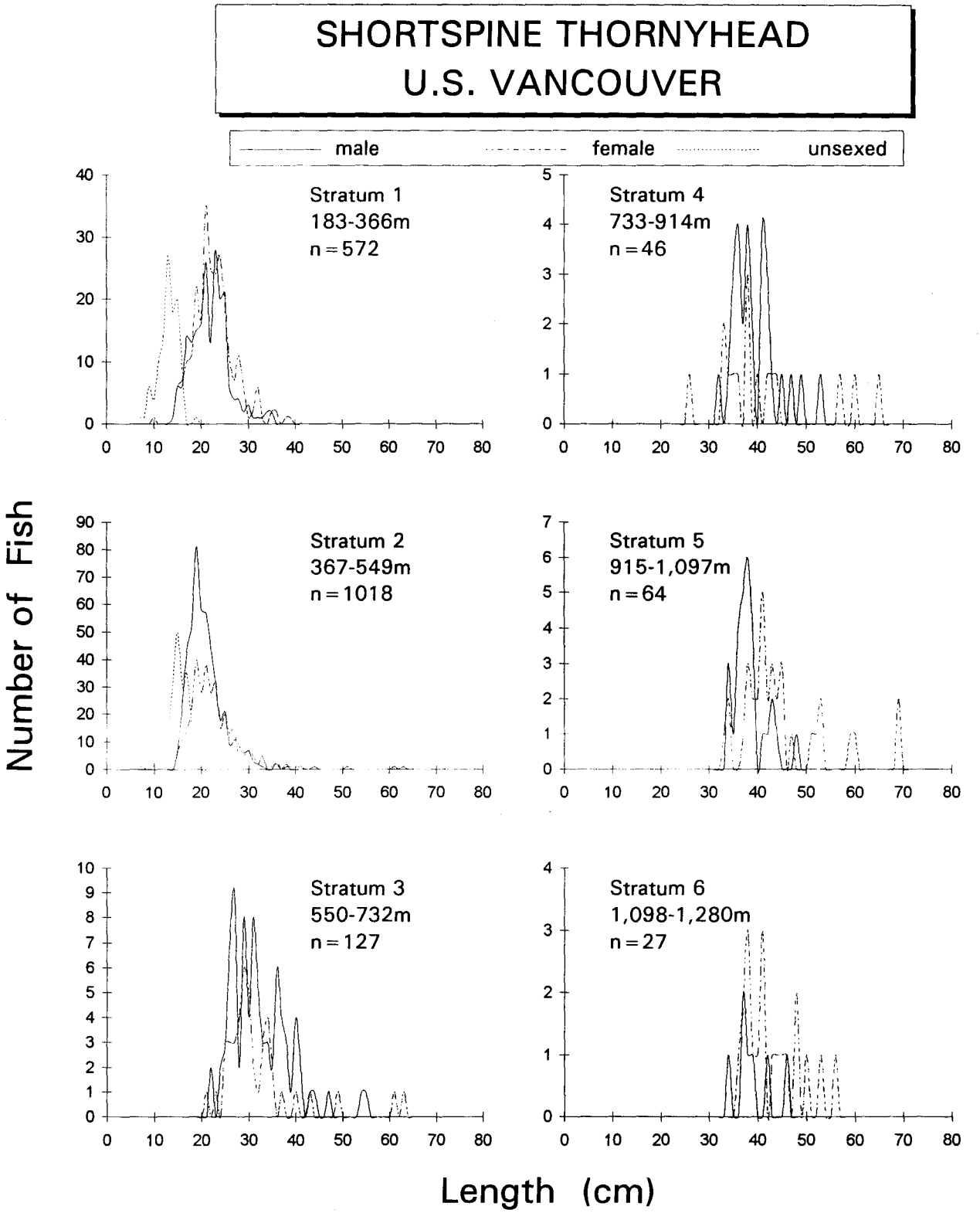

Figure 4.--Unweighted length frequency of shortspine thornyhead by sex and by stratum for the U.S. Vancouver INPFC area.

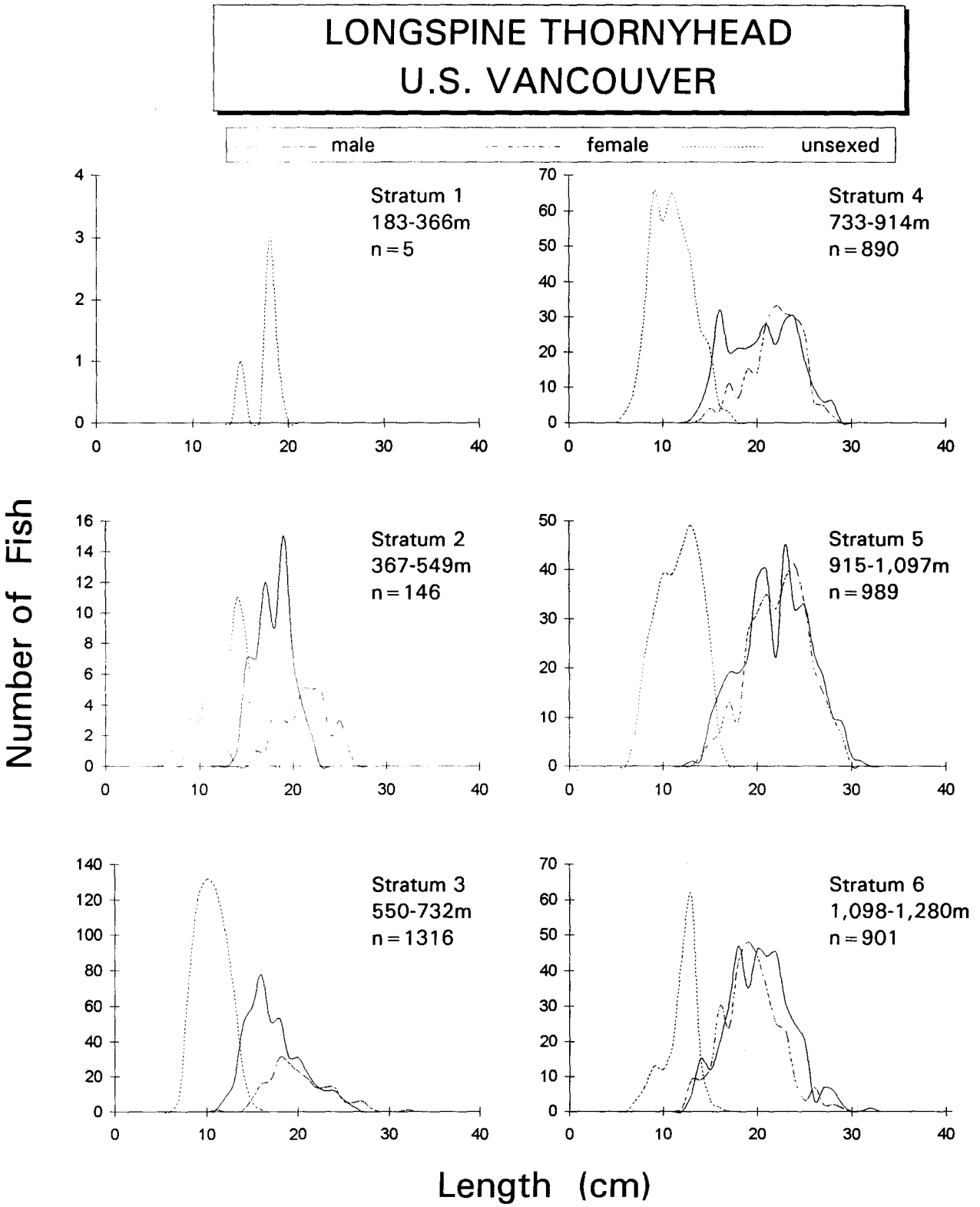

Figure 5.--Unweighted length frequency of longspine thornyhead by sex and by stratum for the U.S. Vancouver INPFC area.

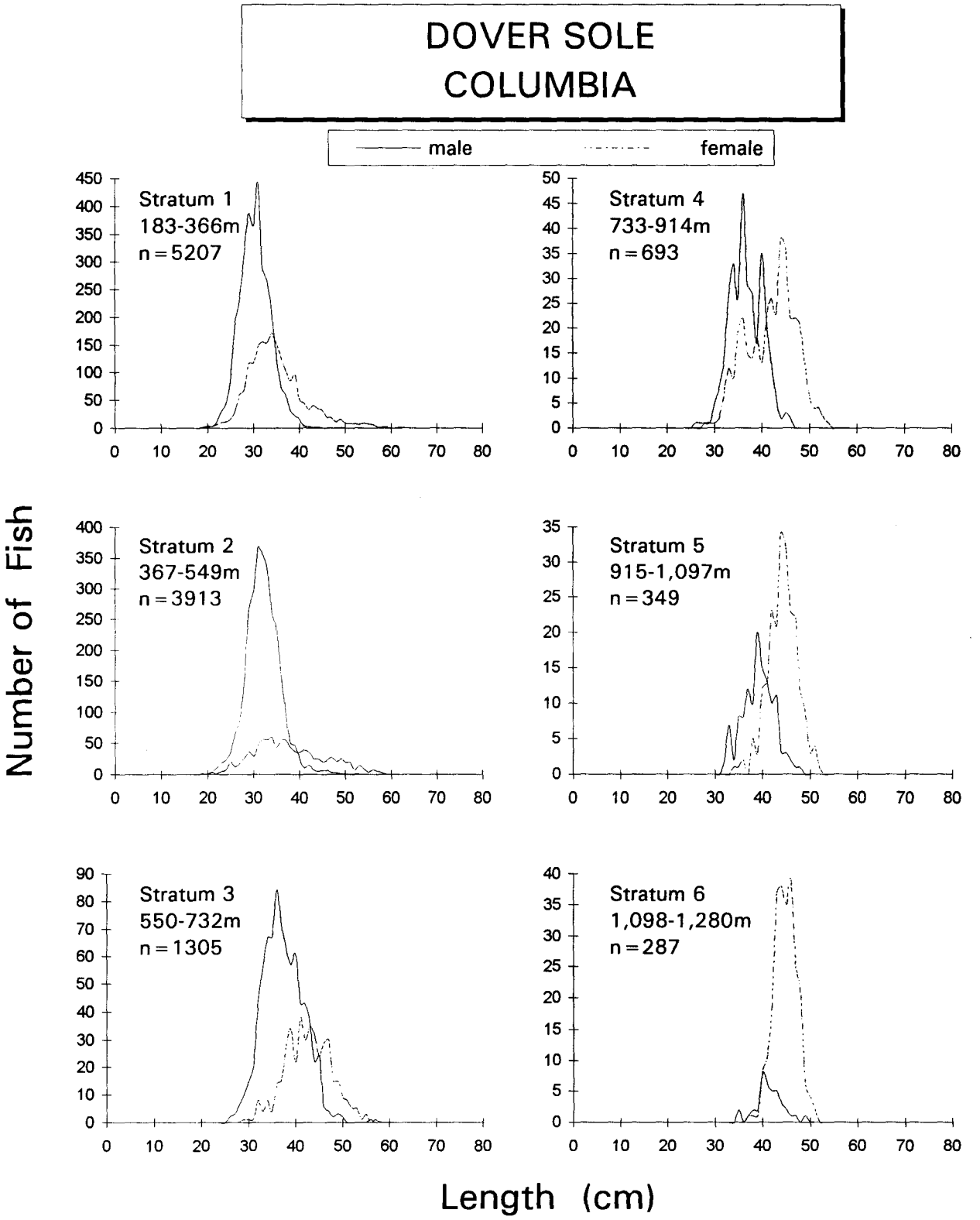

Figure 6.--Unweighted length frequency of Dover sole by sex and by stratum for the Columbia INPFC area.

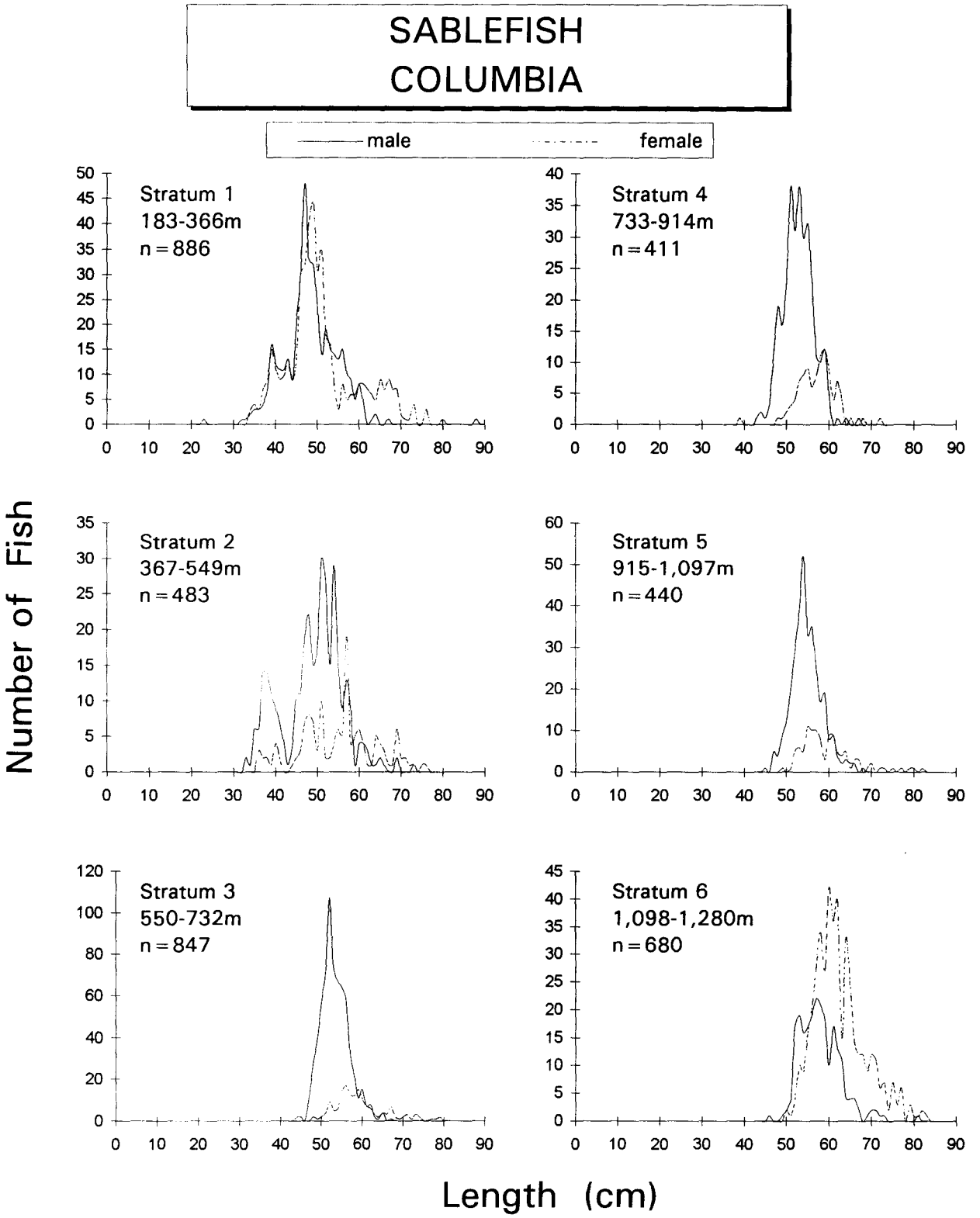

Figure 7.--Unweighted length frequency of sablefish by sex and by stratum for the Columbia INPFC area.

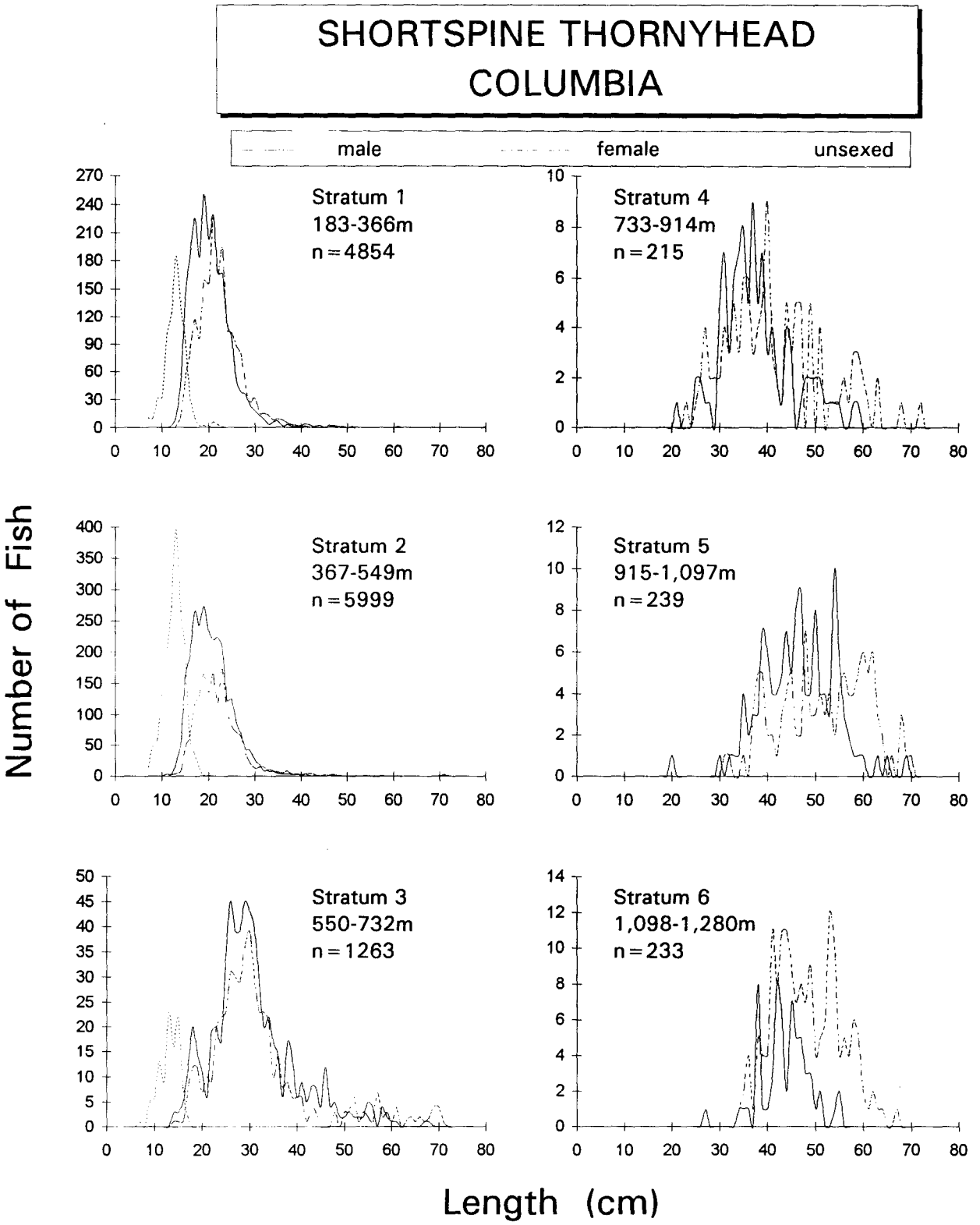

Figure 8.--Unweighted length frequency of shortspine thornyhead by sex and by stratum for the Columbia INPFC area.

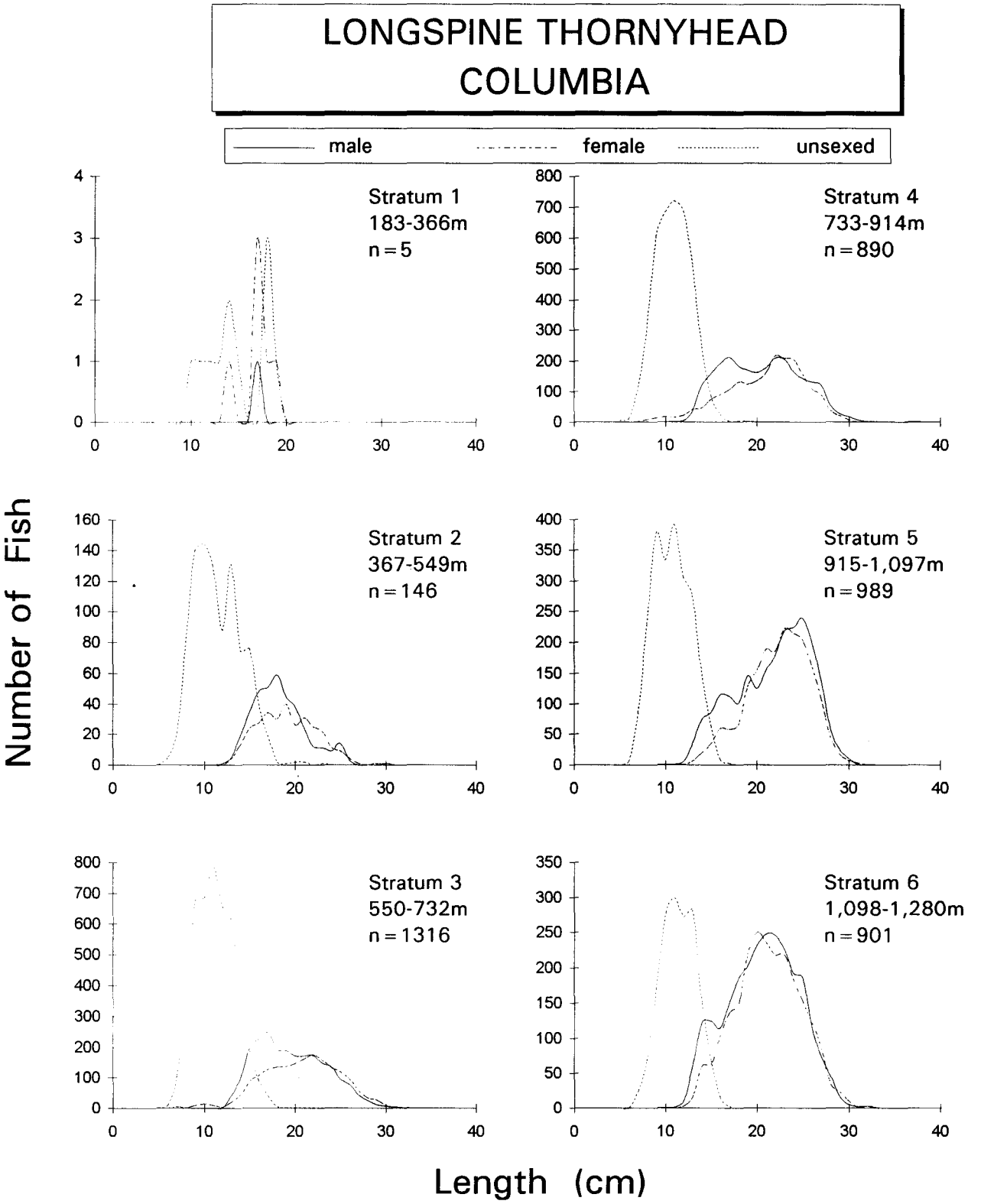

Figure 9.--Unweighted length frequency of longspine thornyhead by sex and by stratum for the Columbia INPFC area.